THE SEVERE WINTER OF 1976–77: PRECURSORS AND PRECEDENTS

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ABSTRACT

The severe winter of 1976–77 over the eastern United States was related to an exceptionally strong and unusual pattern of tropospheric winds and pressure anomalies that persisted from the previous October. The record bitter cold that occurred during January was additionally due to the southward displacement of the cold polar Low, normally found over Northern Canada, by what appears to have been the strongest blocking High ever observed over the Arctic region. A search of the records turned up several severely cold winters during the 20th Century, with that of 1917–18 being closest to the recent winter in severity, with similar antecedent and concurrent phenomena.

1. Introduction

Following a series of generally mild winters over the eastern United States beginning in 1971–72, the extremely cold winter of 1976–77 came as a rude shock to most people, causing fuel shortages and generally slowing, and in some areas, even crippling commerce and transportation. Due to its severity, the persistent and extreme cold seemed totally unprecedented and somewhat unexpected. Because of the serious economic impact of the winter weather, two questions have frequently been asked:

(1) How far ahead was, or might have been, the severely cold winter predicted?
(2) Was such a winter really unprecedented, or have similar winters occurred in the past?

This paper will attempt to provide at least partial answers to these two questions.

2. Atmospheric Circulation Preceding the 1976–77 Winter

As noted above, the 1976 77 winter was preceded by 5 consecutive generally mild winters over the eastern part of the country. The 5-year mean 700-mb height anomaly for the winters 1971–72 through 1976–77 is shown in Figure 1. It can be seen that heights were generally below normal over Canada and the North Atlantic, with a strong Icelandic Low and a generally contracted polar vortex (strongest westerlies at middle and high latitudes). The anomalous strength of the mid-latitude westerlies over the Atlantic sector is especially noteworthy. There was no evidence of high latitude blocking (anomalously high heights at polar latitudes) over the Western Hemisphere. Positive height anomalies over the central Pacific, southwest Atlantic and central Europe indicated stronger than normal subtropical Highs over both oceans, with a continental extension of the Azores High into Europe.

This pattern favors the containment of Arctic air at relatively high latitudes and anomalous advection of mild maritime air from the Gulf and south Atlantic over most of the United States east of the Mississsippi River. Colder than normal air would be favored only over portions of the Great Plains, Rocky Mountains and Great Basin area, and even that would not be too cold due to the lack of a long anomalous fetch directly from Arctic areas. Note that this 5-year mean circulation pattern has almost exactly the opposite departure from normal as that shown by Namias (1970) to have characterized the generally cold winters of the decade from 1960–61 throught 1969–70.

An evolution of the unusual atmospheric circulation patterns over the Northern Hemisphere can be traced forward from the summer of 1976 (Figure 2). A double-lobed strong polar Low as found over the Arctic, and faster than normal westerlies extended across the Pacific. Stronger than normal ridges were associated with persistent heat and drought over the north-central United States and adjacent areas of Canada, as well as the British Isles and Western Europe. In this latter area, some locations experienced the worst summer heat and drought in over 2 centuries. Perry (1977) believes the drought in England and Wales was also related to a marked eastward displacement of the Asian coastal trough, as well as the northward-displaced westerlies over the North Atlantic persisting from several previous seasons.

During the fall of 1977 (Figure 3), the circulation pattern became strongly amplified over most of the Northern Hemisphere. Strong troughs were located over the Aleutians and eastern North America, while a greatly amplified full-latitude ridge extended northward near the West Coast of North America. The subtropical highs over both the Atlantic and Pacific were stronger than normal, with generally fast westerlies across both oceans except for the eastern Pacific, where the flow became more meridional. The remains of the positive anomaly associated with the British drought had moved northward to an area extending from Greenland to Scandinavia, while a stronger than normal trough gave heavy rains that decisively broke the drought in western Europe.

Over the United States, the greater than normal component of northerly flow produced a persistently cold and dry fall, except along the southern border where moisture overrunning the cold air led to some rather heavy rains. The normal fall rainy season in the Pacific Northwest and British Columbia for all practical purposes, failed to begin as the strong ridge deflected Pacific storms northward to Alaska, where many places along the south coast had record heavy rains during the fall.

3. The Winter Circulation Pattern

The longitudinal positions of the troughs and ridges remained remarkably constant from fall to winter (Figure 4). The cyclonic circulation around the troughs intensified and expanded southward while a massive area of blocking filled the Arctic region with strong positive anomalies. The intense cyclonic circulation around the Aleutian Low covered nearly the entire pacific north of 30° latitude.